

# Oak Ridge National Laboratory Energy Storage Program

Michael Starke, PhD  
Power Electric Systems Integration Group  
Oak Ridge National Laboratory

ORNL is managed by UT-Battelle, LLC for the US Department of Energy



U.S. DEPARTMENT OF  
**ENERGY**

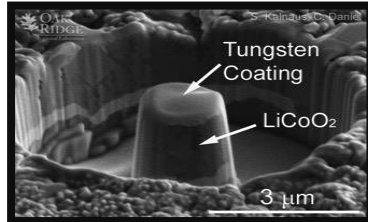
# Oak Ridge National Laboratory



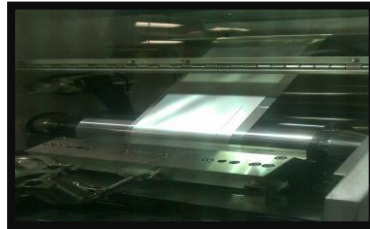
# Energy Storage Research

## Oak Ridge Core Technology Areas

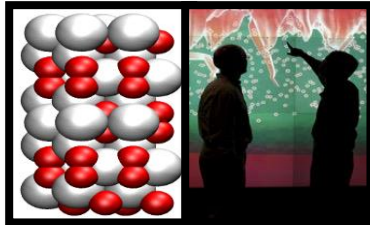
### Materials



### Advanced Manufacturing



### Computation and Analytics

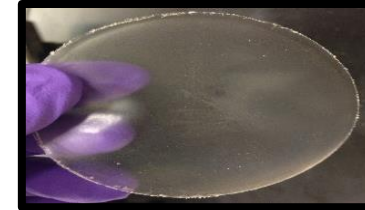


### Systems and Systems Integration



## DOE Energy Storage Program

### Cost Competitive and Long Duration



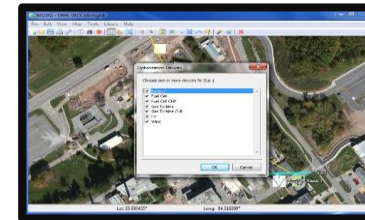
### Validated Safety and Reliability



### Grid Deployments and Field Validations



### Equitable Regulatory Environment

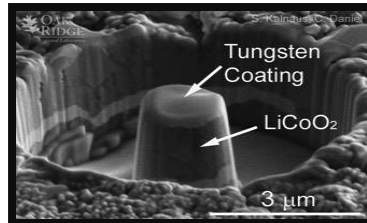




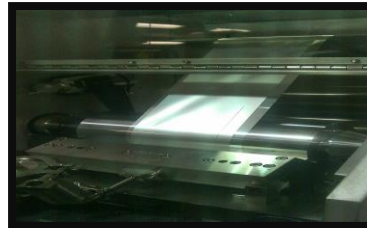
# Facilities and Capabilities

## Oak Ridge Core Technology Areas

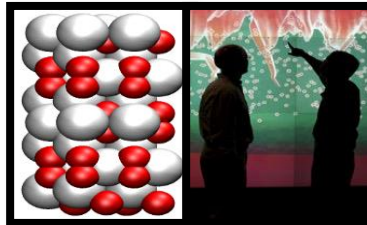
### Materials



### Advanced Manufacturing



### Computation and Analytics



### Systems and Systems Integration



## Oak Ridge Supporting Facilities



Battery Manufacturing Facility (BMF)



Center for Nanophase Materials Science (CNMS)



Grid Research Integration and Deployment Center



Oak Ridge Leadership Computing Facility (OLCF)

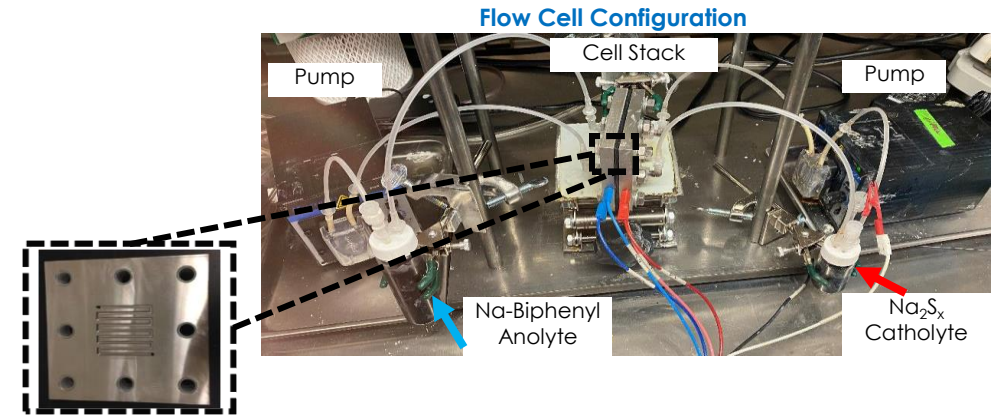
# Energy Storage Projects Under DOE OE Energy Storage Program

## Cost Competitive and Long Duration

### Flow Battery:

Ambient Temperature Polysulfide-Based Redox Flow Batteries and Membrane Development

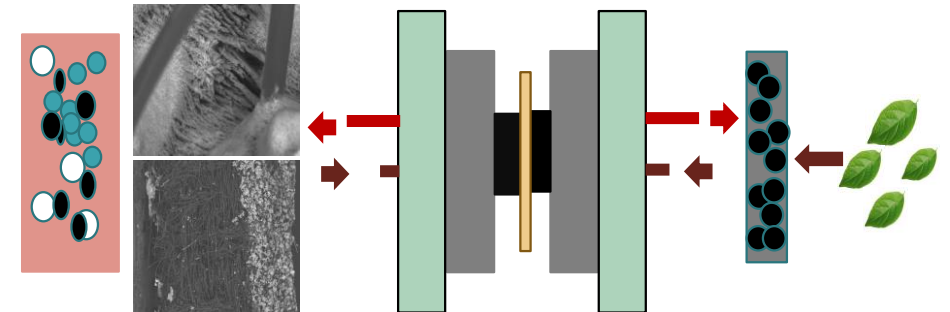
- Jagjit Nanda



### Metal Air Batteries:

Development Of Components and Cell Architectures for High Performance 'Open' Batteries for Grid Applications

- Tom Zawadinski

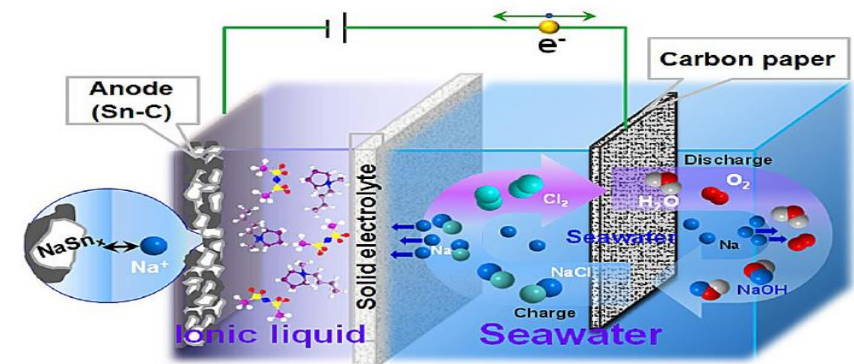


### Saline Batteries:

Development of Saline Battery for Long Duration Energy Storage

- Ilias Belharouak

New



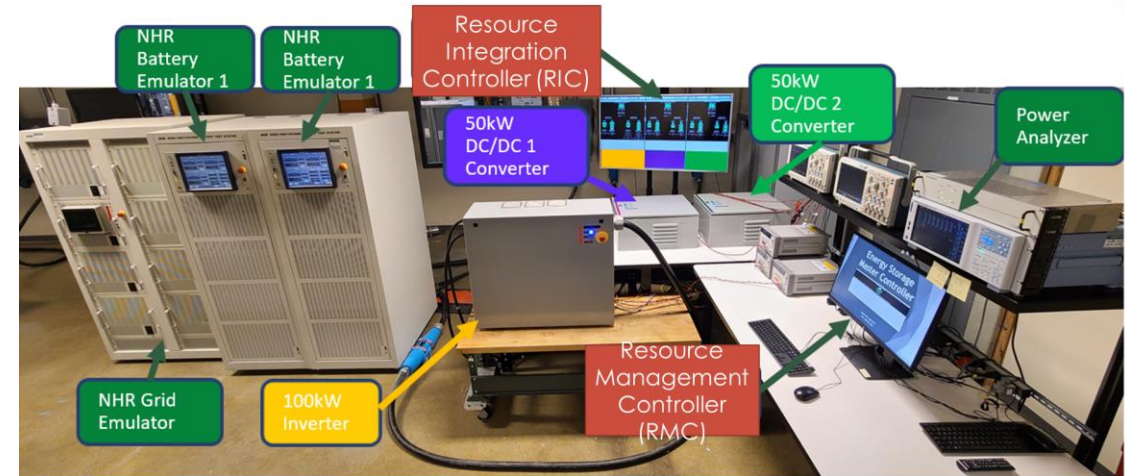
# Energy Storage Projects Under DOE OE Energy Storage Program

## Grid Deployments and Field Validations

### Systems Integration:

Secondary Use Development of a Battery Chemistry Agnostic Secondary Use Energy Storage System

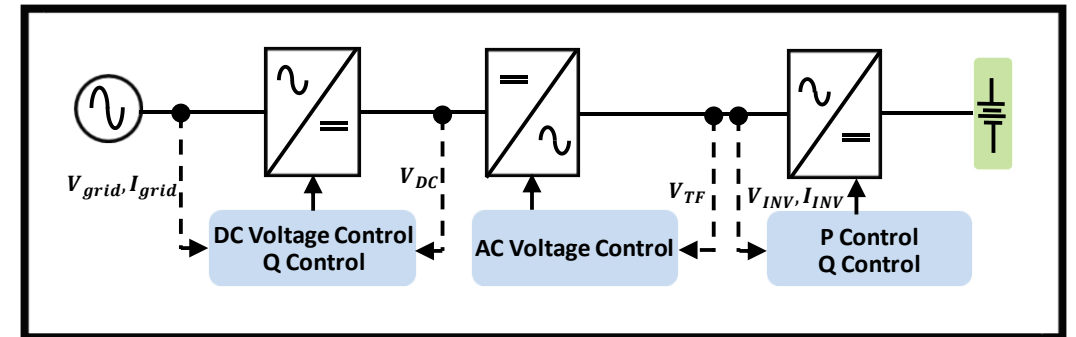
- Michael Starke



### New Grid Interconnections:

Direct-Tied Medium Voltage Energy Storage System Development

- Madhu Chinthavali

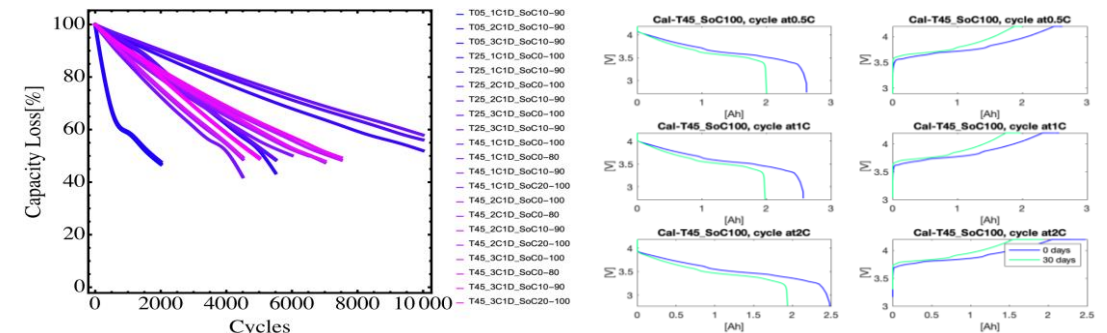


### Modeling:

Remaining cycle life estimation and ageing analysis on secondary use of Li-ion battery MegaPacks

- Srikanth Allu

New





# Energy Storage Projects Under DOE OE Energy Storage Program

## Validated Safety and Reliability

### Establishing Safety Database:

Establishing Thermal Runaway Risk Test Protocols and Database – An ORNL and SNL Collaborative Research on Battery Safety

-Hsin Wang

New

### Early Failure Detection

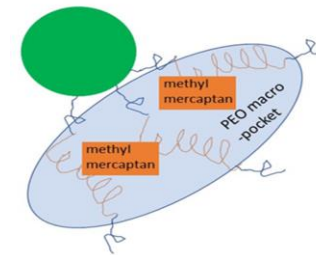
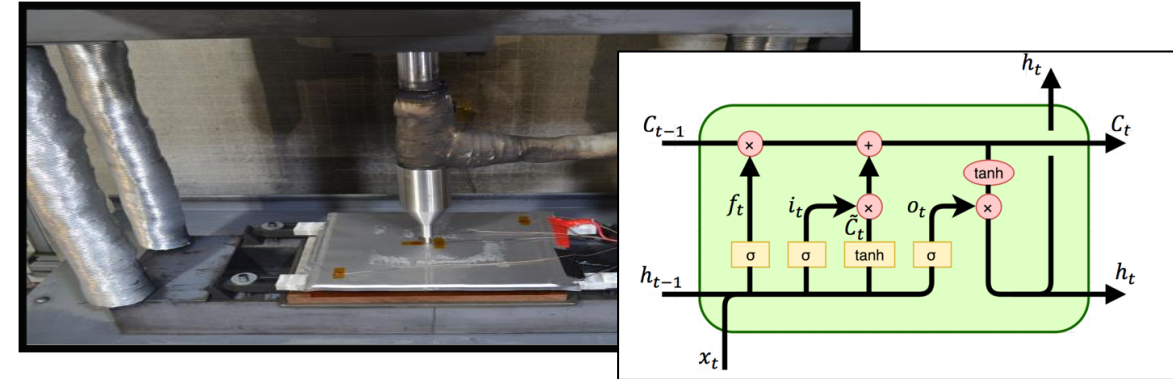
Development of Temperature Sensitive Paint and Battery Management System (BMS) for Energy Storage System (ESS) Safety

- Hsin Wang

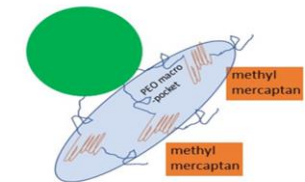
### Advanced Manufacturing:

Low Cost Materials for sodium batteries for Grid Energy Storage

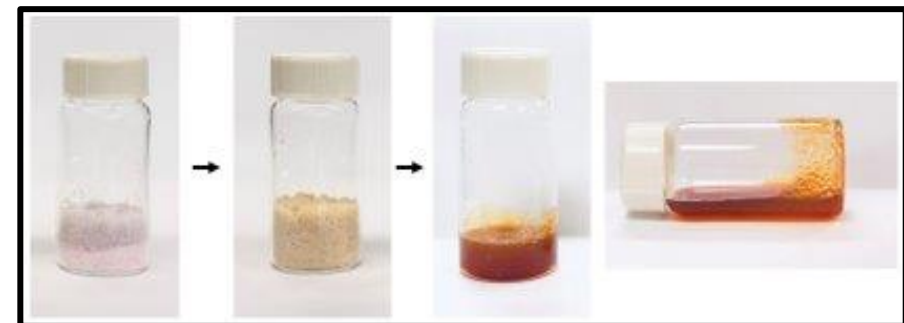
- Ilias Belharouak



Paint additive with trapped mercaptan



Additive with mercaptan release after heating



# Projects Plans Going into FY22

## Cost Competitive and Long Duration

Alkaline Flow Battery:  
Tailored ion selective membranes for mediated alkaline flow batteries (SHIFT)

Zinc-Air Battery:  
High energy Density Zn-air Batteries Toward higher Capacity

Saline Batteries:  
Long Duration Energy Storage Enabled by Sea Water Batteries (Sea-Bat)

Sodium Flow Battery  
Hybrid Sodium Redox-Flow Battery for Grid Storage

New

## Grid Deployments and Field Validations

Systems Integration:  
Secondary Use Development of a Battery Chemistry Agnostic Secondary Use Energy Storage System

New Grid Interconnections:  
Direct-Tied Medium Voltage Energy Storage System Development

Simulation:  
Cell modeling of secondary use systems to understand life impacts following primary application

Learning Algorithm:  
Power electronics interface reliability for long duration energy storage systems

New

## Validated Safety and Reliability

Establishing Safety Database:  
Establishing Thermal Runaway Risk Test Protocols and Database – An ORNL and SNL Collaborative Research on Battery Safety

New Sensing Concepts  
Development of new paint that off gases with temperature

Advanced Manufacturing:  
Low-Cost, Durable Electrochemical Energy Storage for Electricity Grid Applications

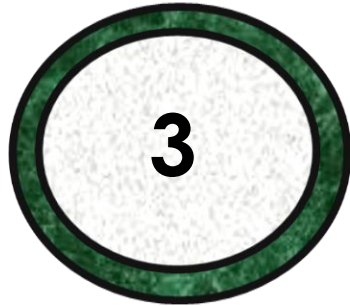
Isolated Systems:  
Integrated Inductively coupled dc-dc battery interface for Safety

New

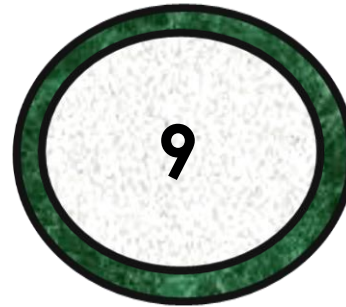


# Program Output FY21

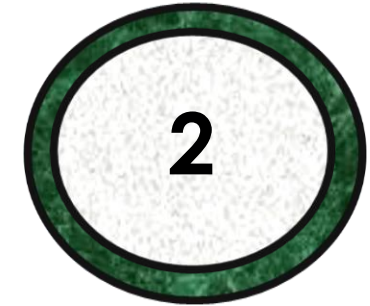
## Conference Papers



## Journals



## Intellectual Property



# Acknowledgements

**This work is supported by Dr. Imre Gyuk, Manager,  
Energy Storage Program, Office of Electricity,  
Department of Energy.**